Smart Projectiles for Environmental Assessment, Reconnaissance and Sensing (SPEARS)

Completed Technology Project (2016 - 2017)

Project Introduction

Our mission archetype is exploration of hazardous, non-planar terrain, such as Martian caves or icy crevasses on Europa. Clusters of SPEARS sensors will be used to gather scientific measurements over a wide area. The major objective of this study is to demonstrate general feasibility of the concept and to make inroads in a few crucial technology bottlenecks. Experimentation with an early terrestrial prototype will demonstrate viability of core ideas and assist in evangelism. We will leverage existing test facilities, like our planetary roverscape, to provide great value relative to funding level. Lastly, analysis of SPEARS architecture in the context of possible future missions will ground this work for NASA relevance. A study in projectile payload selection will be performed, considering environmental and optical sensors. Strategies for anchoring, localization, and comms will be surveyed. Various thrust modalities (e.g. compressed gas vs. mechanical) for the launcher system will also be compared. Most critically, several automated multi-sensor data fusion techniques providing image stabilization, panoramic stitching, and 3D mapping (several of which this team has pioneered) will be evaluated and demonstrated. This will be accomplished by the construction of a basic terrestrial proof-of-concept system comprised of a CO_2 projectile launcher and 2-3 example projectiles such as a camera, illuminator, and radio beacon. Existing algorithms and software will be built upon to demonstrate processing techniques, and extensions implemented to meet observed challenges will directly advance the state of the art.

Anticipated Benefits

Much work in terrestrial field science has been accomplished by human scientists. Unfortunately, planetary environments like icy crevasses, penitente fields, and lava tubes, which are among the highest potential return to science, are too distant, dangerous, and unknown for human exploration in the foreseeable future. Only robotic missions might access these locations with acceptable cost and risk. However, state-of-art in planetary robotics – featuring a single, ponderous rover – falls short of the ability to negotiate such terrain, which may include ingress constraints or vertical obstacle fields. These "mobile lab" type rovers are further unable to accomplish parallel, long-duration science over a wide area. For example, cave biologists have shown the efficacy of dense, spatio-temporal measurement of gasses in order to detect biological signatures (like methane). On earth, spelunkers set up sensor nodes throughout caves and retrieve data drives on subsequent trips, but this approach is not compatible with remote world operation.

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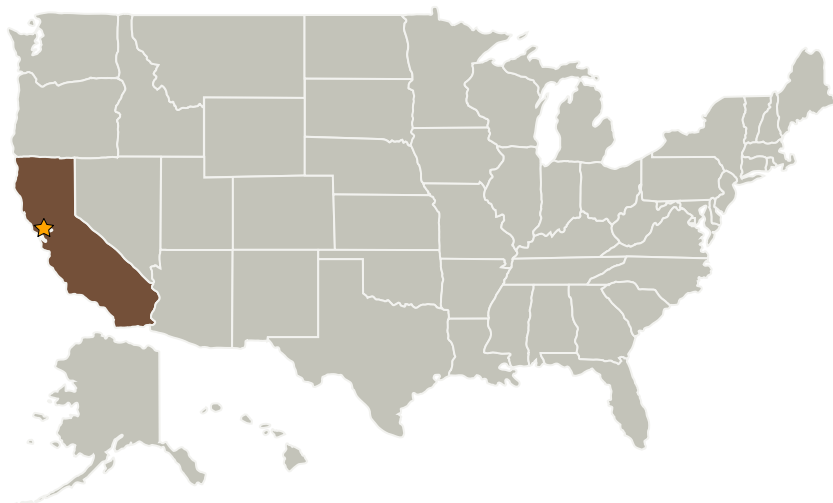
Table of Contents

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Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
⭐Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

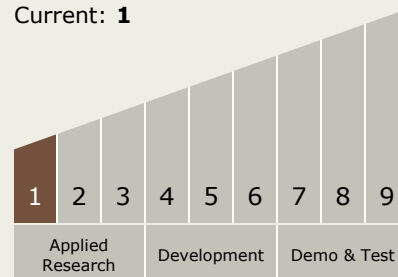Michael R Lapointe

Program Manager:

Harry Partridge

Principal Investigator:

Terrence W Fong

Technology Maturity (TRL)

Start: **1**
Current: **1**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

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Page 2

Technology Areas

Primary:

- TX04 Robotic Systems
  └ TX04.2 Mobility
    └ TX04.2.4 Surface Mobility

Target Destinations

Earth, The Moon, Mars, Others Inside the Solar System